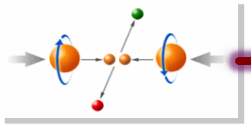
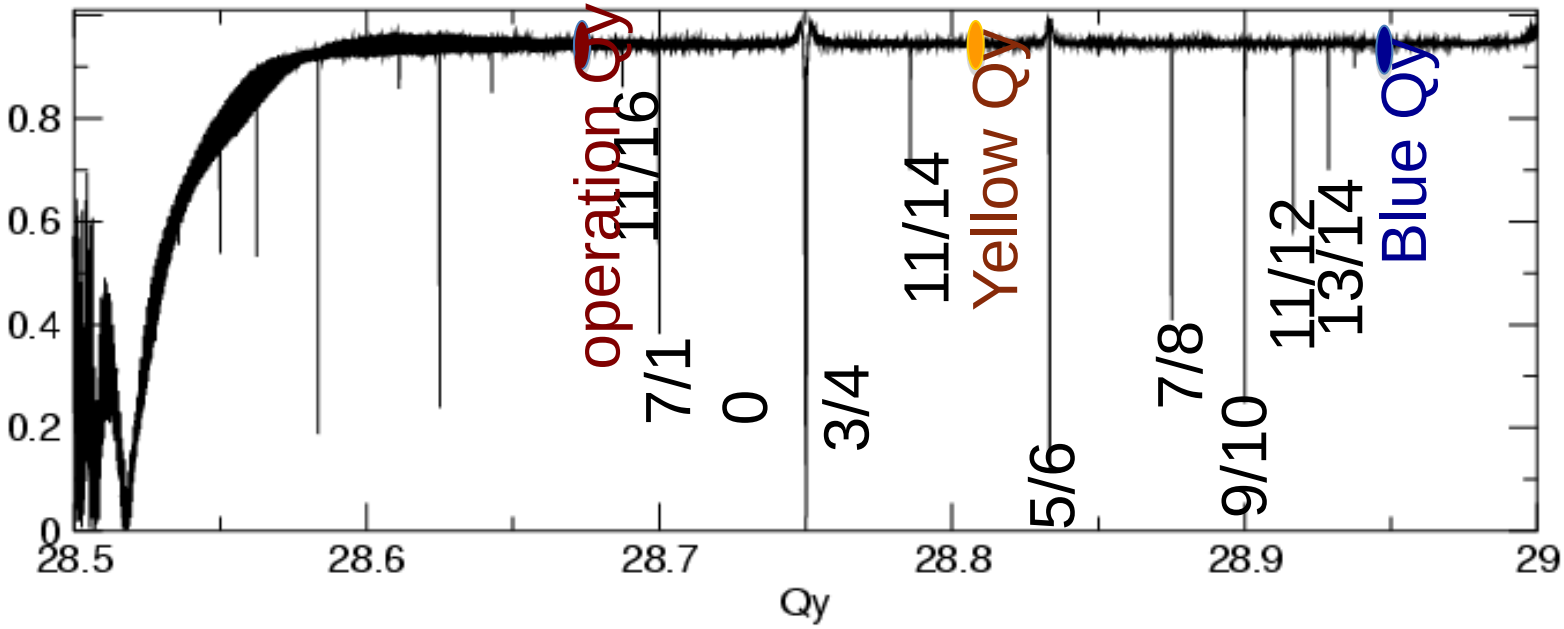


Polarization and Operations at the Near Integer Working Point

M. Bai, V. Ptitsyn, Y. Luo, G. Marr, A. Marusic, M. Minty, H. Huang, T. Roser, V. Schoefer, S. Tepikian, W. Fischer, T. Satogata, A. Zelenski, N. Tsoupas

Motivation of Operating at Near Int Working Pt

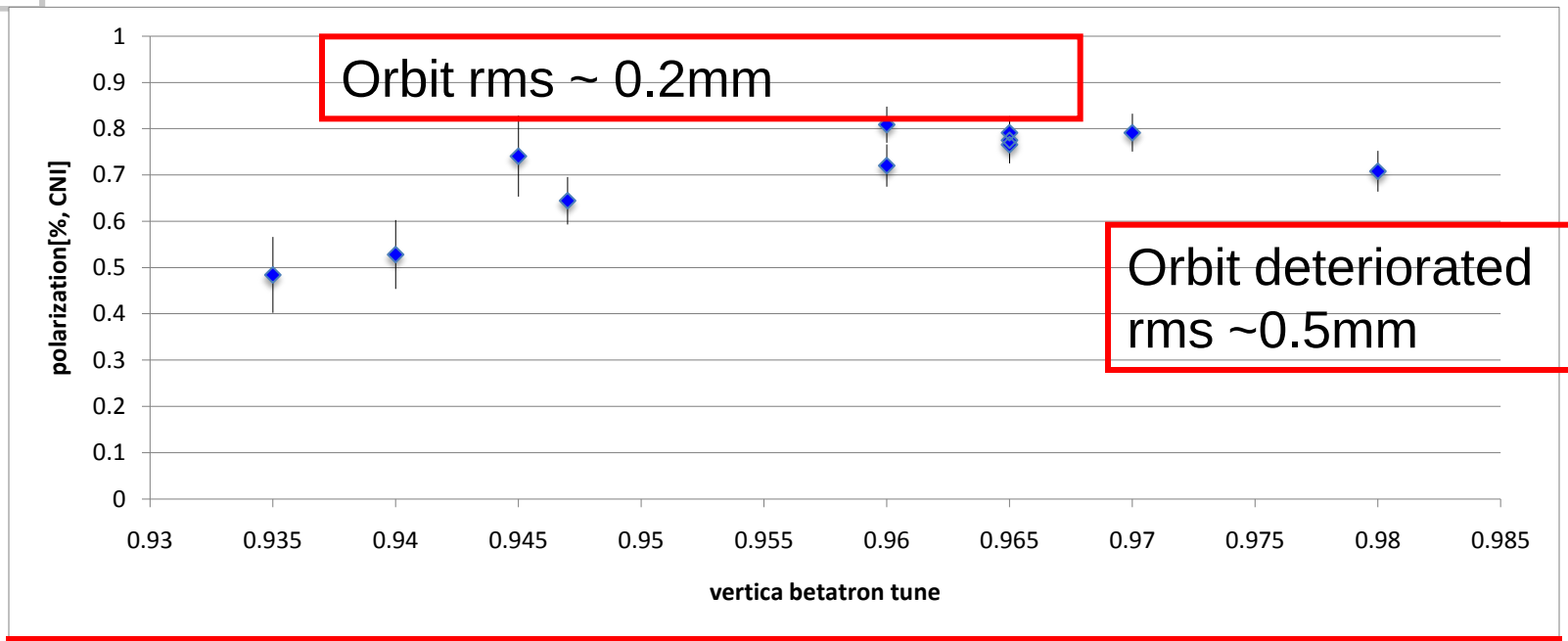
- Goal:
  - Look for new working points which 100% polarization can be achieved
  - Candidate:
    - Near integer: > 0.94
    - RHIC pp design working point: 0.81
- Setup: pp94nearInt
  - Blue wp: Qx=27.88, Qy=0.955
  - Yellow wp: Qx=27.82, Qy=28.81



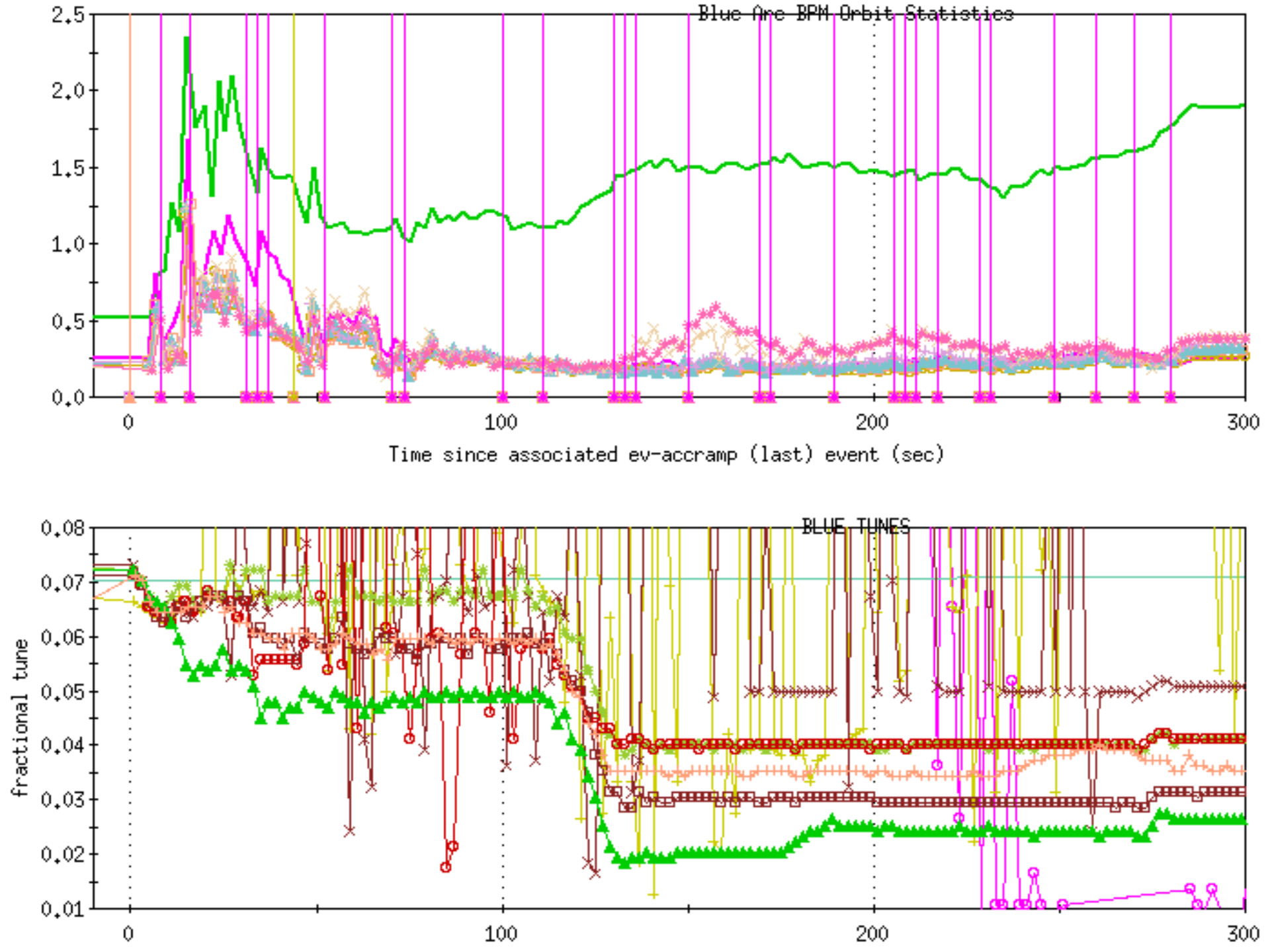
Accelerating PP with near Integer Vertical Tune

- A total of ~41 hours were spent on near Integer study
  - More than 3 hours for testing ps with the new ramp
  - 38 hours with beam
    - 2 hours in establishing circulating beam at injection
    - 3 hours in setting up tune/coupling feedback at injection: good investment
    - 3 hours in ramping both beams to 250 GeV
    - exploring polarizations with different vertical tunes
- Critical instrumentation
  - Tune and coupling feedback
  - Orbit correction
  - CNI polarimeter: 12 bunches with noiminal bunch intensity
  - IPM: Wrong optical function in the application led us to spend time to investigate emittance issues

Summary of polarization studies: Blue



- Best orbit rms achieved ~0.2 mm
- Highest polarization transmission efficiency achieved in Blue
  - Qy > 0.955
- Data indicate less snake resonances in the neighborhood towards integer


Blue Arc BPM Orbit Statistics
2.5
2.0
1.5
1.0
0.5
0.0
0
100
200
300
Time since associated ev-accramp (last) event (sec)
BLUE TUNES
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
fractional tune
0
100
200
300

Summary of polarization studies: Yellow

Fill #	Qx	Qy	Pol [%] err
10945	0.820	0.830	40.9 3.8
10946	0.820	0.8333	25.5 3.9

Yellow: (0.82, 0.83)

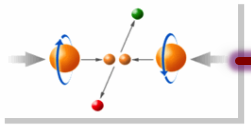
- achieved ~0.2mm and better orbit rms
-observed snake resonances at 0.8333
- no detailed tune scan

Preliminary Conclusions and Plans

- Both highest polarization and polarization transmission efficiency achieved are lower than what we had with working point towards 2/3 resonance. Possible speculations
  - Stable spin direction was significantly deviated away from vertical due to
    - Stronger intrinsic spin resonance
    - Stronger imperfection resonace
- Can near Integer tune work for polarization?
  - Need to understand what we observed: Spin tracking with realistic RHIC model
    - Magnet errors as well as misalignment
    - Sextupole fields
    - Snake errors: how well do we know the snake rotates the spin vector by 180 degrees?
    - Synchrotron motion
    - Tune spread

Acknowledgement

- Special Thanks to
  - Fulvia, the APEX coordinator
  - Christoph: 100 GeV RUN coordinator
  - Don Bruno, Carl and other power supply experts
  - Operation crews in MCR



RHIC Spin Flipper Status

M. Bai, T. Roser, P. Pile, Y. Makdisi, C. Pai, P. Oddo, T. Russo,
A. Luccio, P. Rosa, I. Maneris, J. Scaduto, C. Dawson,
S. Nayak, M. Maples, J. Sandberg, J. Tuozzolo, A. Pendzick

Summary of Commissioning

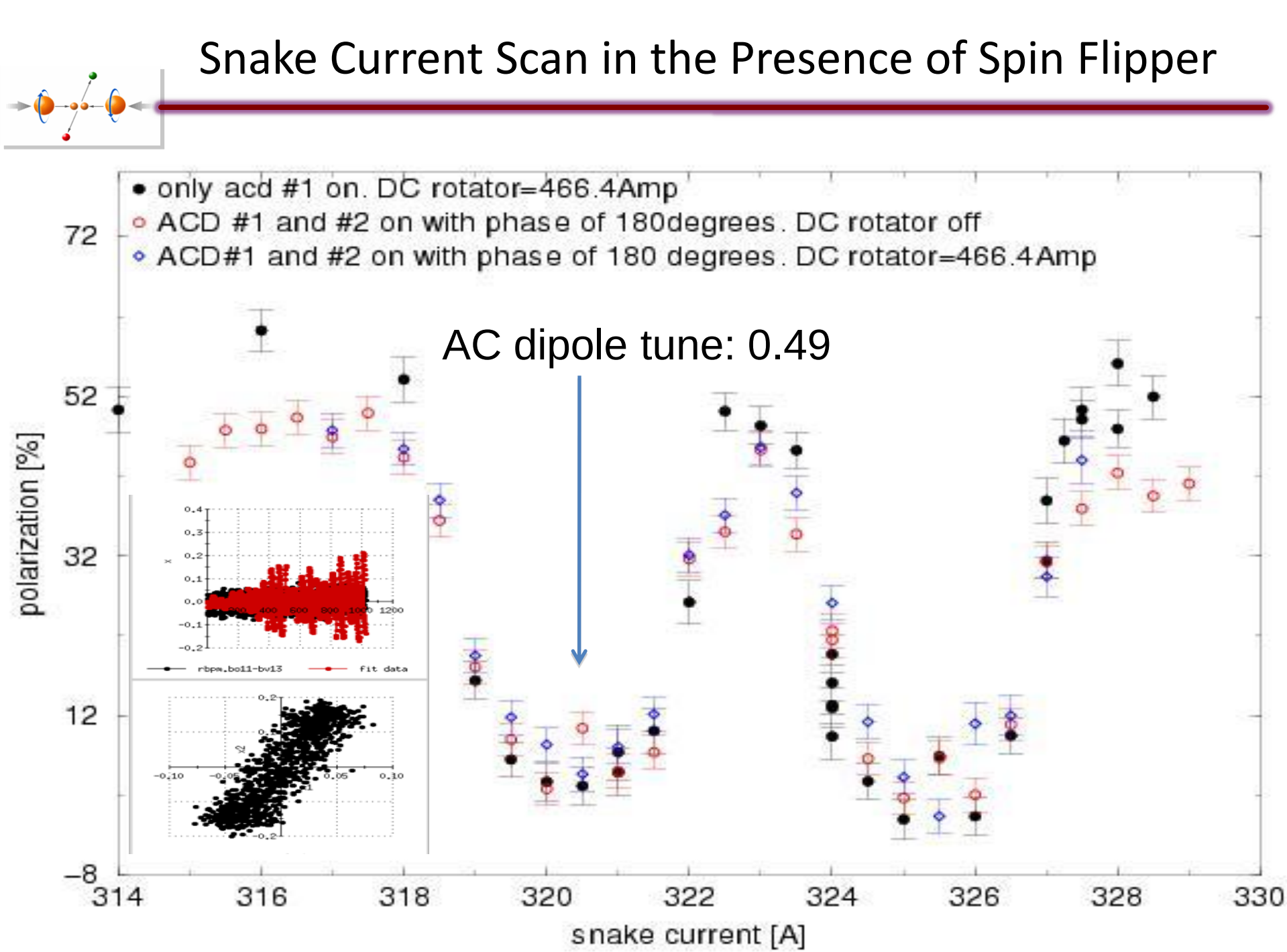
- DC dipoles reached max current of 500A. Orbit response due to the dc dipoles was completely closed within the spin flipper

- AC dipole system with the mechanical tunable inductor worked well. The additional feedback system added close to the of the run helped to keep the current fixed while the tune was swept from 0.49 to 0.51

- The coherent oscillation excited by the ac dipole(s) is global and had effect on the Yellow beam through beam beam

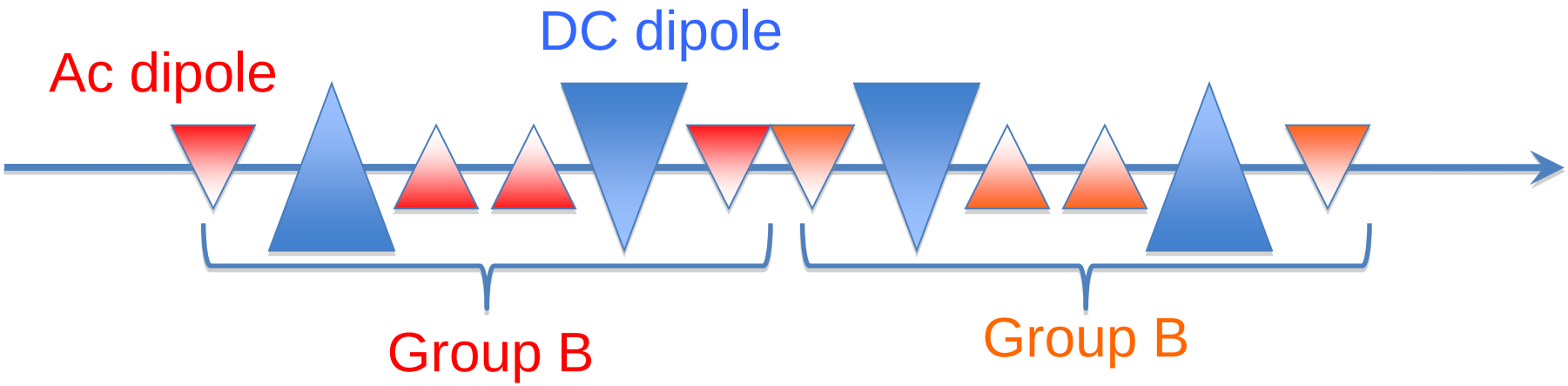
- Measurements of single ac dipole at fixed tune of 0.49 as well as dual ac dipoles at the same tune with different relative phases were made. These measurements showed that the polarization effect of the ac dipole(s) was dominated by the polarization perturbation from quadrupoles due to the coherent driven betatron oscillation

Snake Current Scan in the Presence of Spin Flipper



New Design

- New design:
  - localize the ac ipole driven oscillation within spin flipper
  - Add three new ac dipoles.
  - Increase the DC dipole current to 1500 Amps



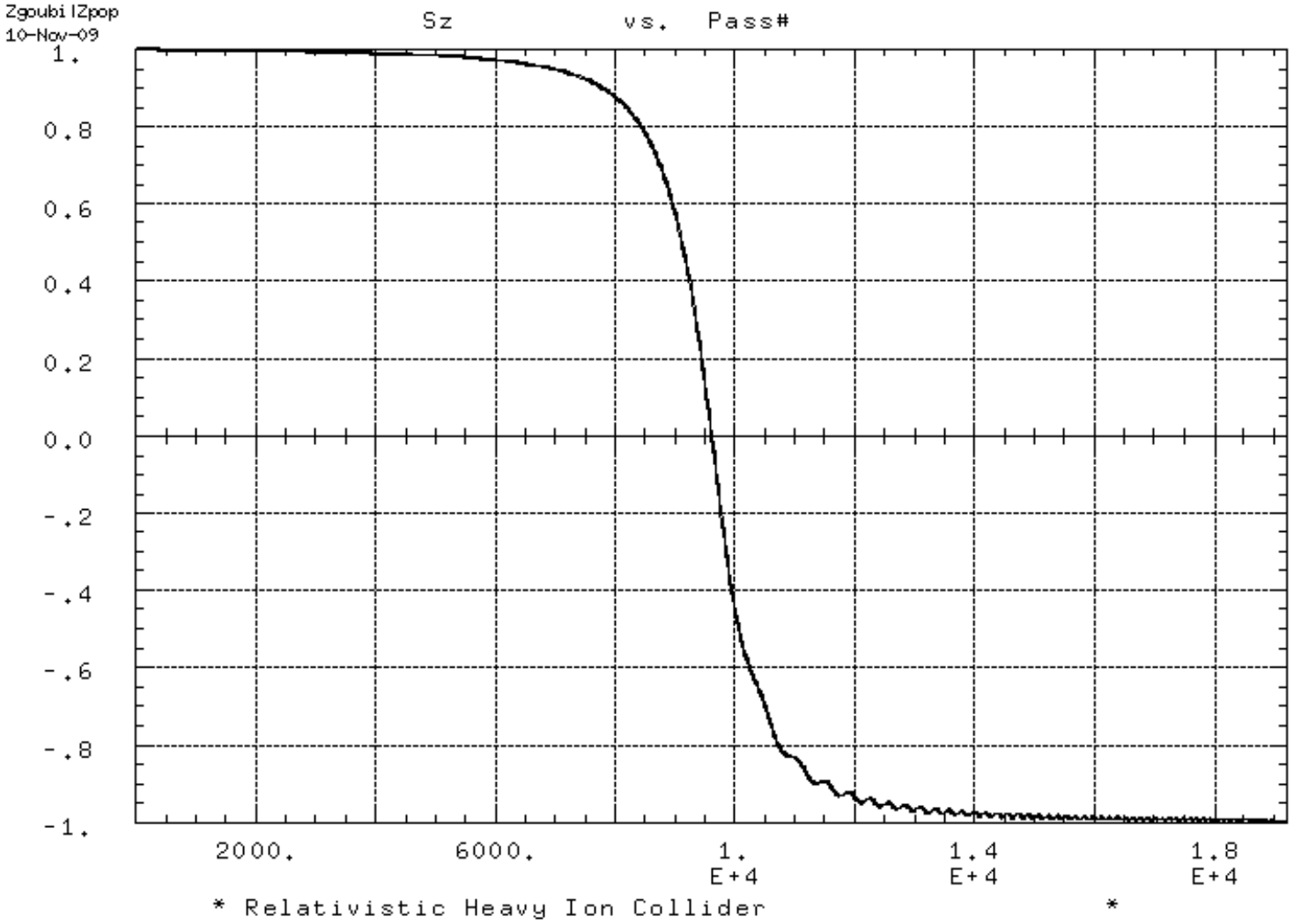
Rotating field strength:

$$4\psi_V \sin(\psi_H/2)\sin(\psi_H)$$
$$= 0.52\ \psi_V \quad for\ \psi_H = 30^\circ$$
$$= 1.08\ \psi_V \quad for\ \psi_H = 45^\circ$$

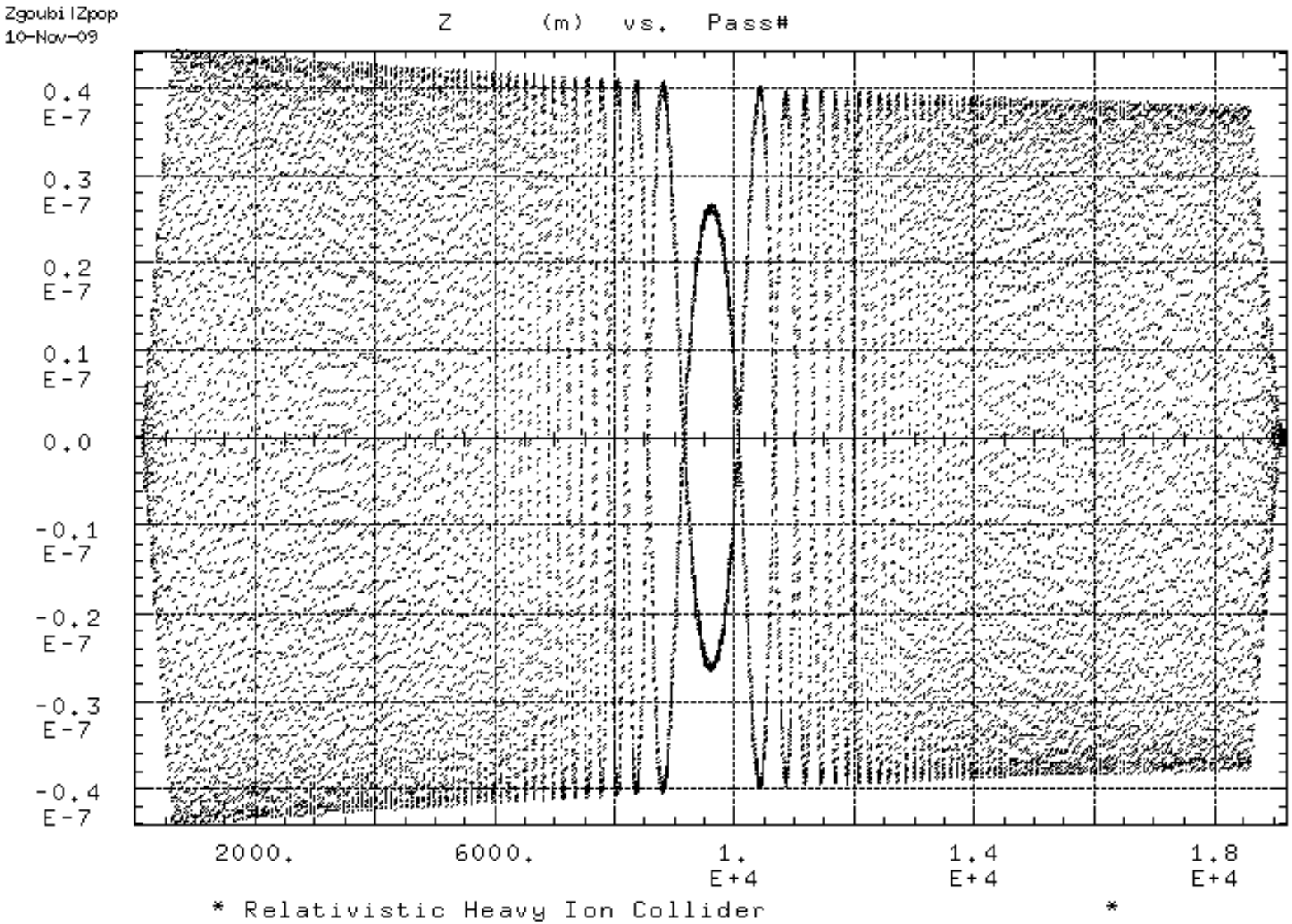
Phase relations:

$$\chi_A - \chi_B = \psi_H$$

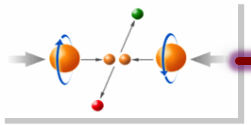
Simulation of New Design: zgoubi



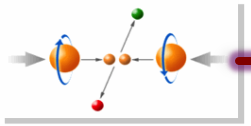
Residual Orbital Response



Plan for RUN2010

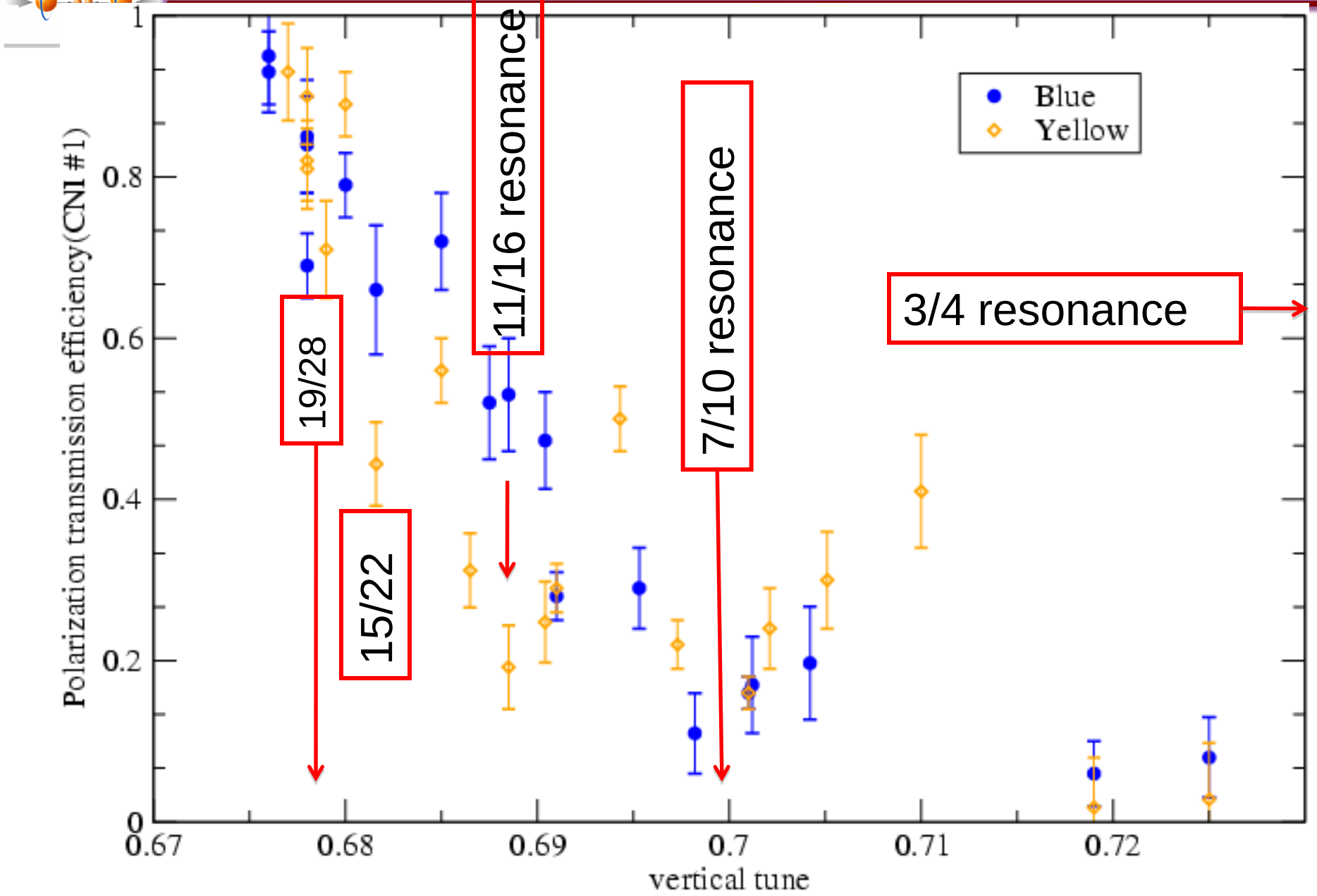


- Spin tracking
  - with the old design to understand the snake current scan data
  - with the new design t
- Test the closure ac dipole bump
  - Adding the ac dipole in the middle of the the spin flipper
    - Expect magnet coil end of Nov.
    - Expect magnet stand Installation: working progress
    - Vacuum work including installation of the ceramic pipe: working progress
    - Magnet will be installed during maintenance
  - **Measure the residual coherent oscillation beyond spin flipper**



Bakeups

Tune Scan of 250GeV: gg260, gg381, gg422

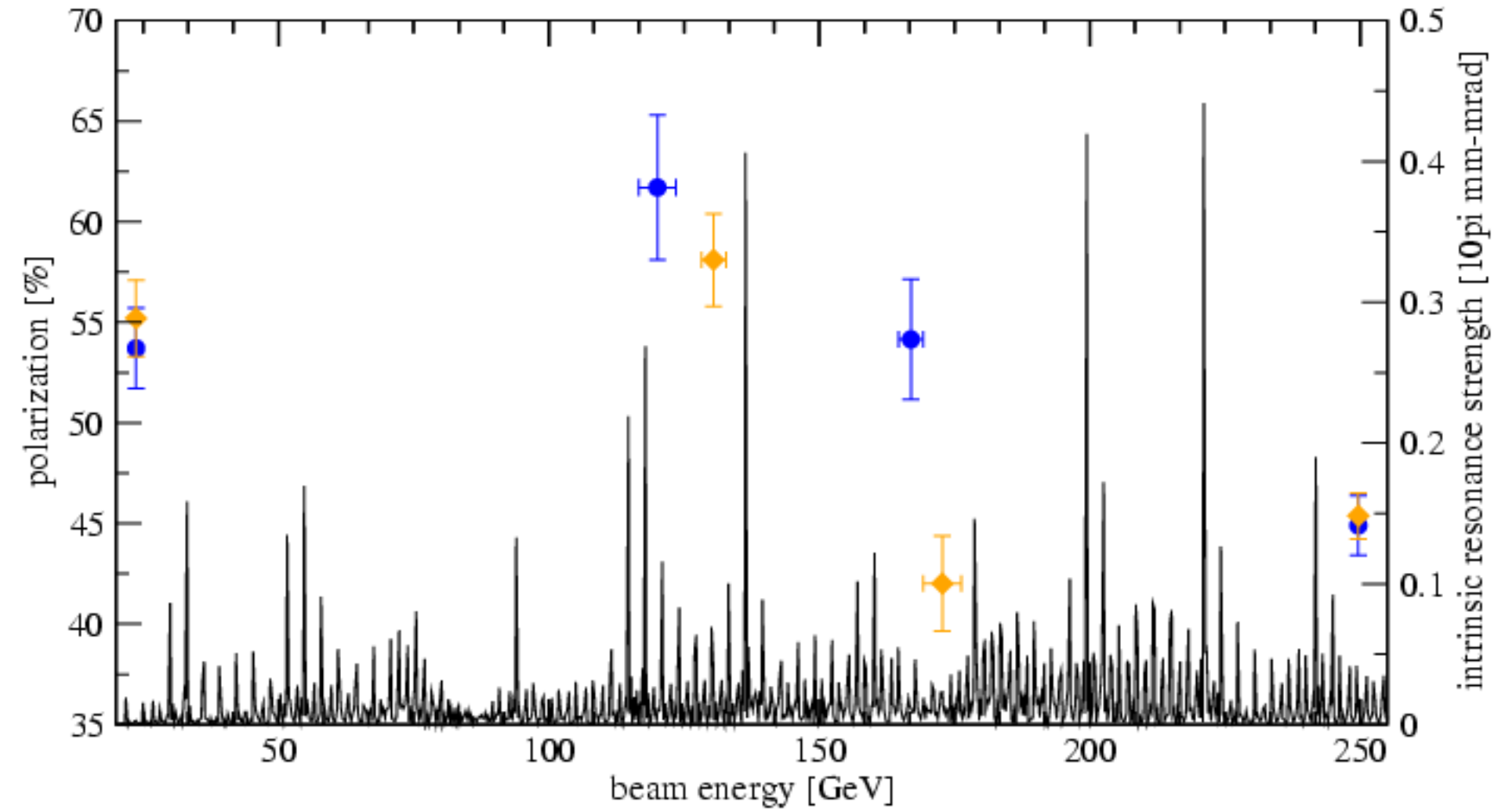


Polarization Tune Scan Study

- Study carried out with 56 bunches with 1.2x10^11 protons per bunch. No rotators.
- Very poor polarization profile data
- Polarization transmission efficiency approaching 90% and higher when vertical tune goes 0.675 and below.
  - Leads to the APEX proposal for RUN 10 to explore the possibility to accelerate pp at a vertical tune 0.675 or below from 100 GeV to 250 GeV
- Data indicate higher order snake resonances, worse in Yellow
  - Errors in snake? How accurate do we the angle the spin vector gets rotated by the snake(s)?
  - Need spin tracking w. realistic RHIC model to guide
- Very strong ¾ resonance. Is an rms ~0.3mm orbit distortion enough?

Polarization Status: 250 GeV

- polarization were lost beyond 100 GeV to 250 GeV
- Average polarization transmission efficiency: ~80%
- Best polarization achieved w.o. rotator: ~54%



List of Polarization Studies in RUN 09

- Polarization as function of vertical tune:
  - Participants: M. Bai, H. Huang, …, operations
- Accelerating polarized proton with near integer vertical tune
  - Participants: M. Bai, V. Ptitsyn, H. Huang, T. Roser, S. Tepikian, T. Satogata, G. Marr, V. Schoefer, A. Marusic, M. Minty, Y. Luo, W. Fischer, MCR crew
- Spin tune as function of energy
  - Participants
- Polarization lifetime as function of spin rotator setting at IP8
  - Participants: PHENIX polarimeter, operations